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**Cole et al.**

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(54) **OPTICAL FIBER CONNECTOR ASSEMBLY WITH PRINTED CIRCUIT BOARD STABILIZATION FEATURES**

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**H05K 1/11** (2006.01)  
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USPC ..... 385/88-92, 134-139, 147; 361/804  
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,779,674 A \* 10/1988 McNulty ..... 165/80.2  
6,830,382 B1 12/2004 Deane

(Continued)

FOREIGN PATENT DOCUMENTS

EP 0245195 11/1987  
JP 2001-094273 4/2001

(Continued)

OTHER PUBLICATIONS

International Search Report for PCT International Application No. PCT/US2012/066628, mailed on Feb. 26, 2013, 7 pages.

*Primary Examiner* — Akm Enayet Ullah

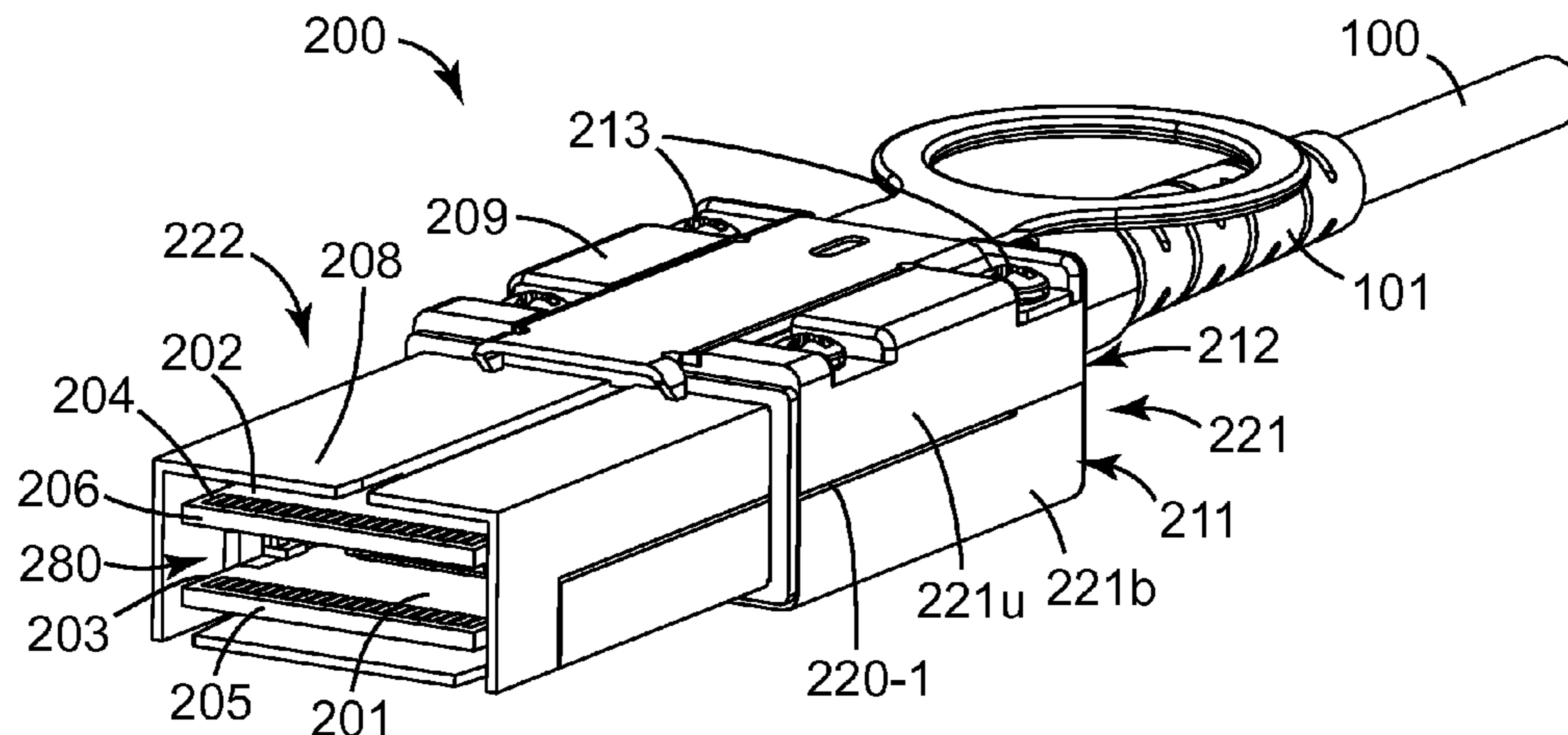
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(57) **ABSTRACT**

A plug connector for connecting a cable to a receptacle connector includes a housing (209) comprising an upper housing portion (212) assembled to a lower housing portion (211), the assembled portions defining a cavity (280) within the housing. One or more printed circuit boards (201, 202) are disposed in the housing cavity and a cable (100) is disposed in the housing cavity and connected to printed circuit boards. The assembled upper and lower housing portions define a first housing sidewall comprising an upper sidewall portion (221u) at the upper housing portion and a lower sidewall portion (221b) at the lower housing portion. The upper and lower sidewall portions define a gap (220-1) in the first housing sidewall at an interface between the upper and lower sidewall portions of the first housing sidewall. The gap extends only partially or at least partially along a length of the first housing sidewall.

**13 Claims, 6 Drawing Sheets**



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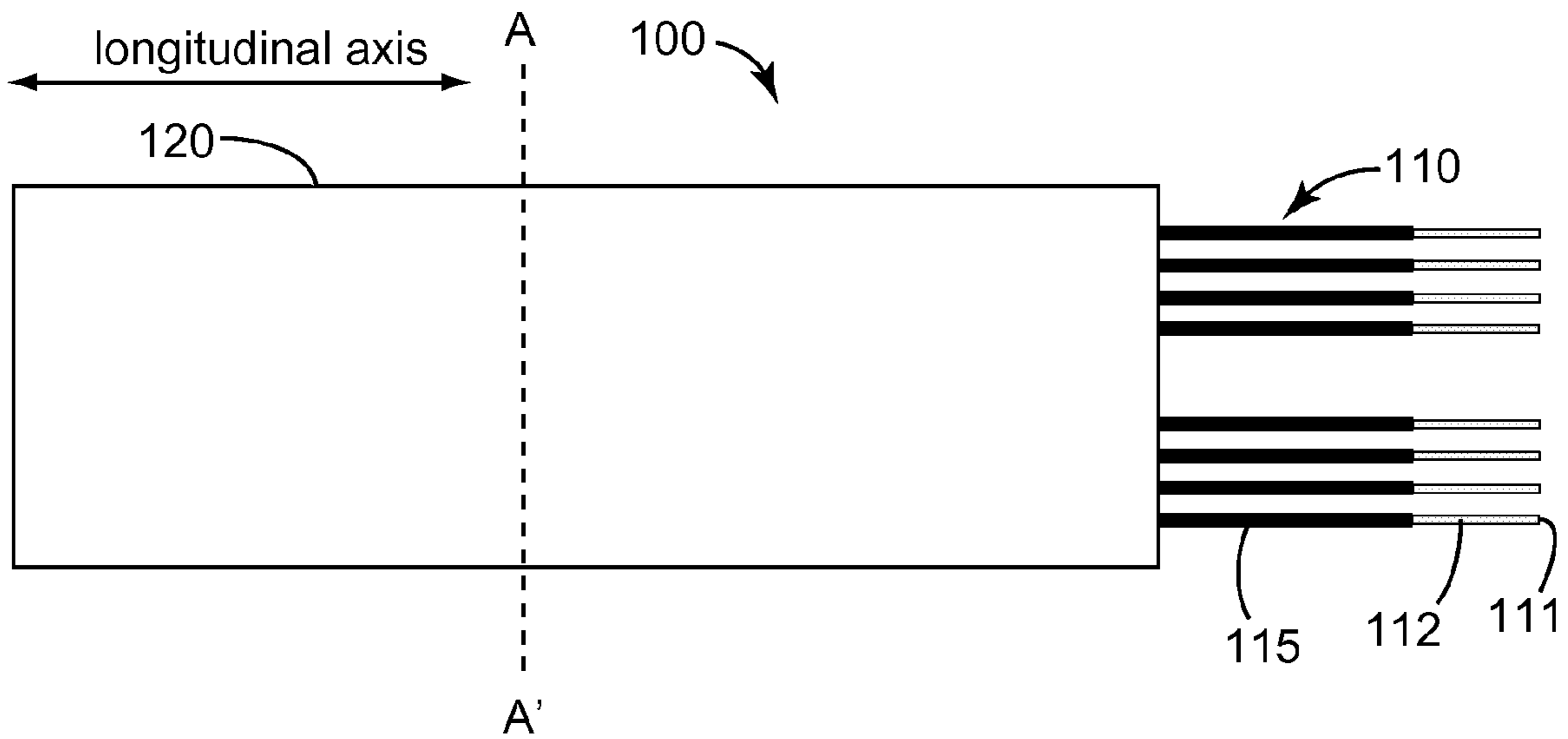
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*H05K 1/14* (2006.01)
- (52) **U.S. Cl.**  
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- 2005/0178568 A1 8/2005 Ito  
2007/0071390 A1 3/2007 Tobiason  
2007/0232118 A1 10/2007 Wu  
2009/0297099 A1 12/2009 Benjamin  
2010/0027955 A1 2/2010 Parikh  
2010/0080518 A1\* 4/2010 Teo et al. .... 385/92

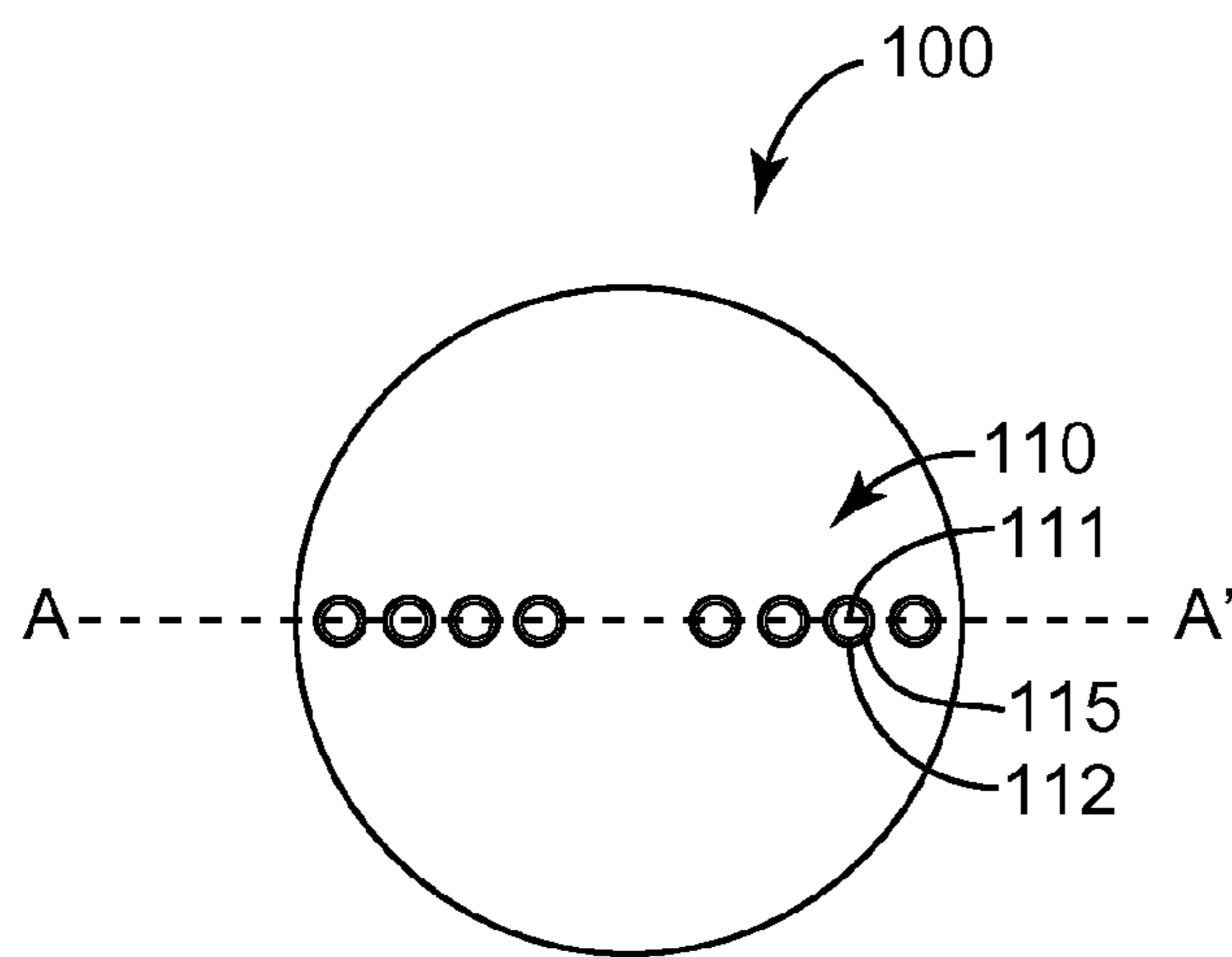
## FOREIGN PATENT DOCUMENTS

- (56) **References Cited**
- U.S. PATENT DOCUMENTS
- 6,994,478 B1 2/2006 Chiu  
2004/0101259 A1 5/2004 Kilian
- WO WO 98-40774 9/1998  
WO WO 2011-056733 5/2011  
WO WO 2013-081795 6/2013

\* cited by examiner



**FIG. 1A**



**FIG. 1B**

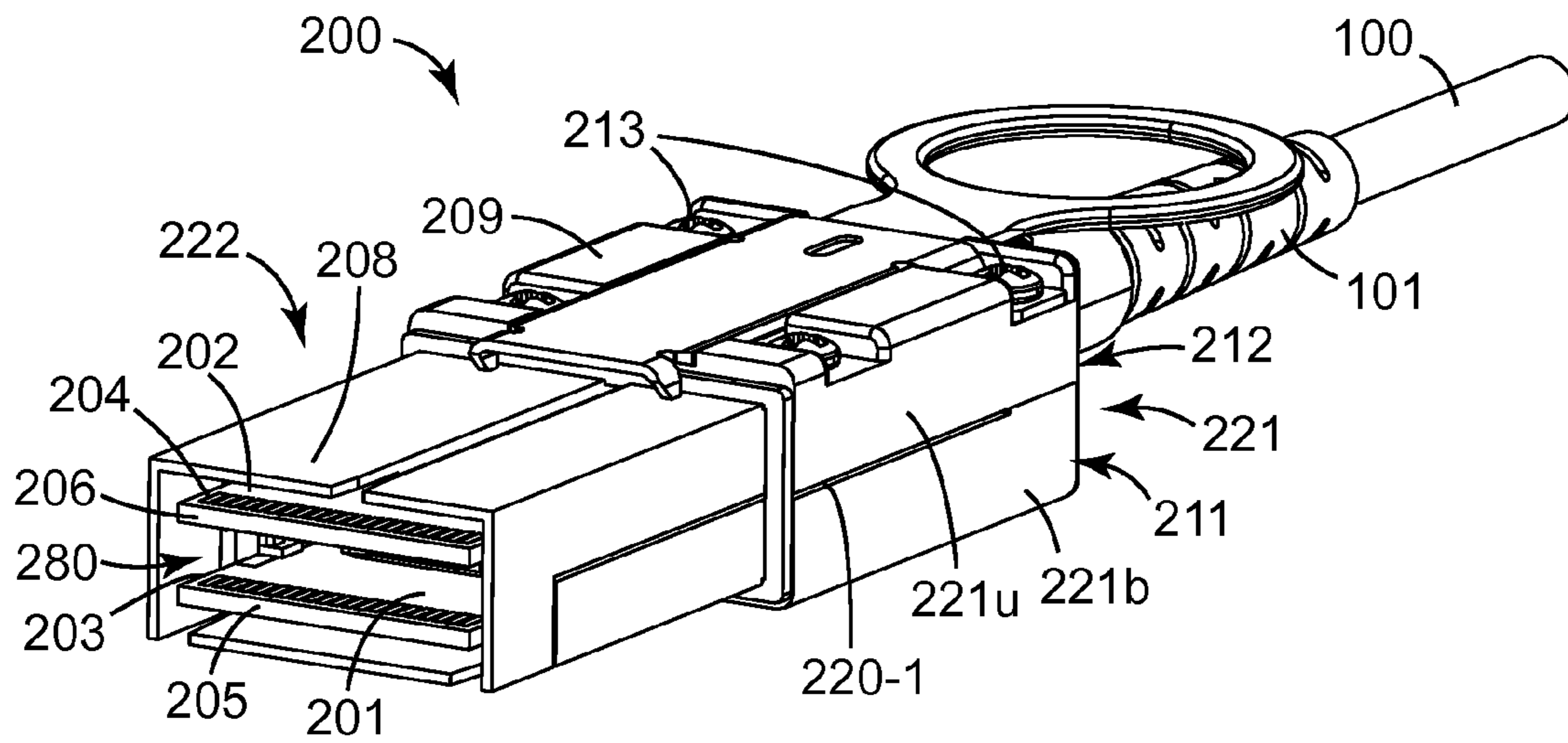


FIG. 2A

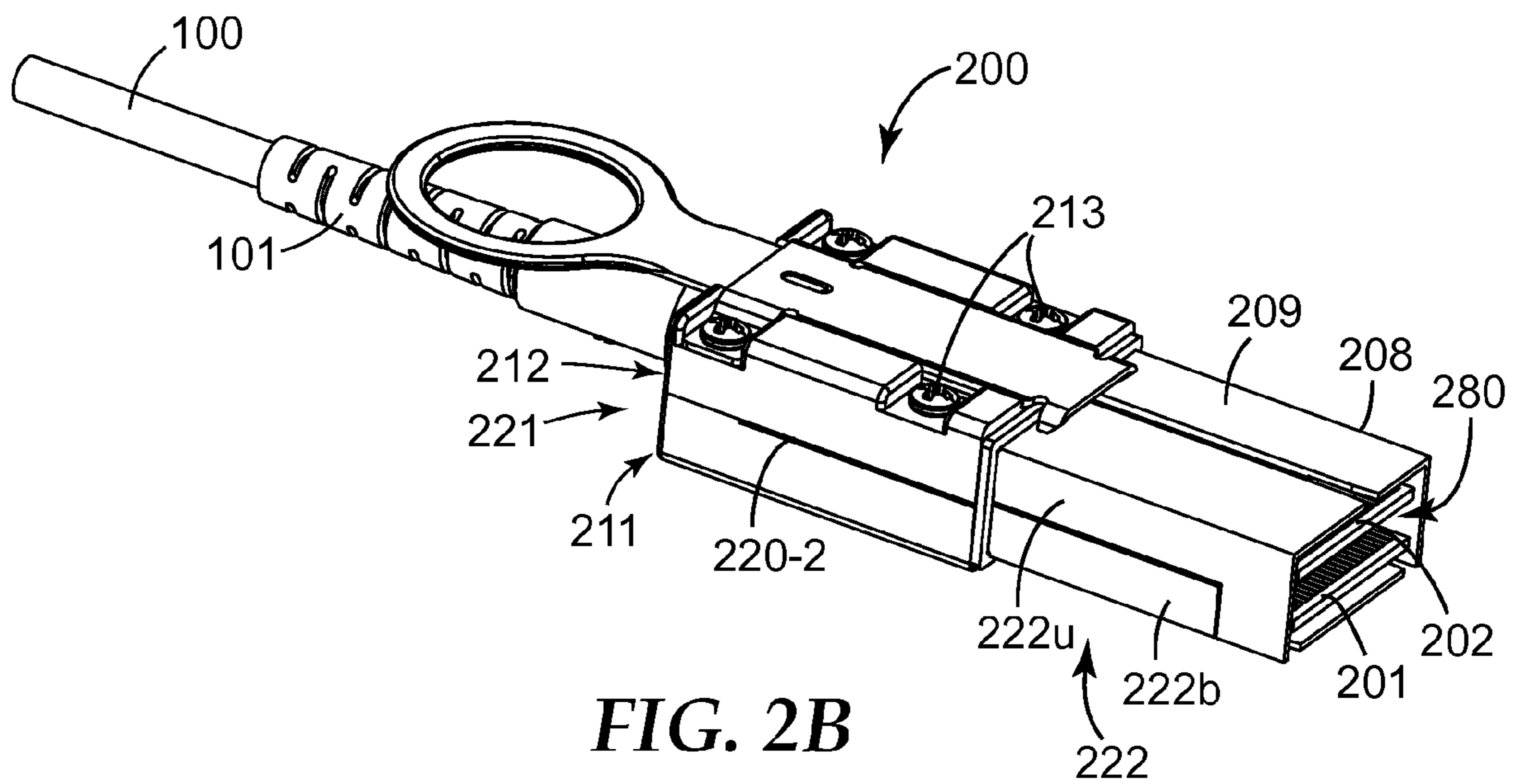


FIG. 2B

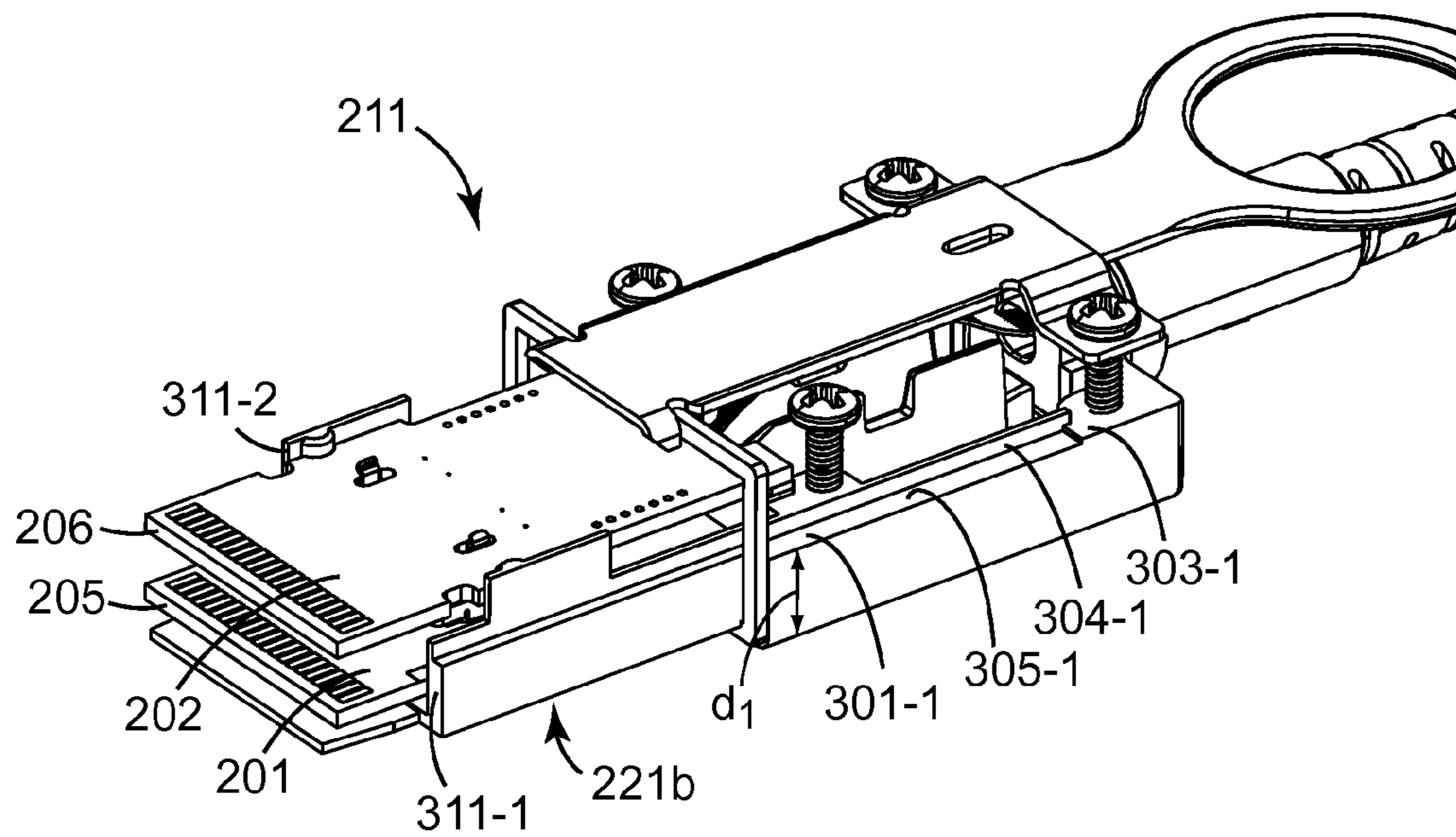


FIG. 3A

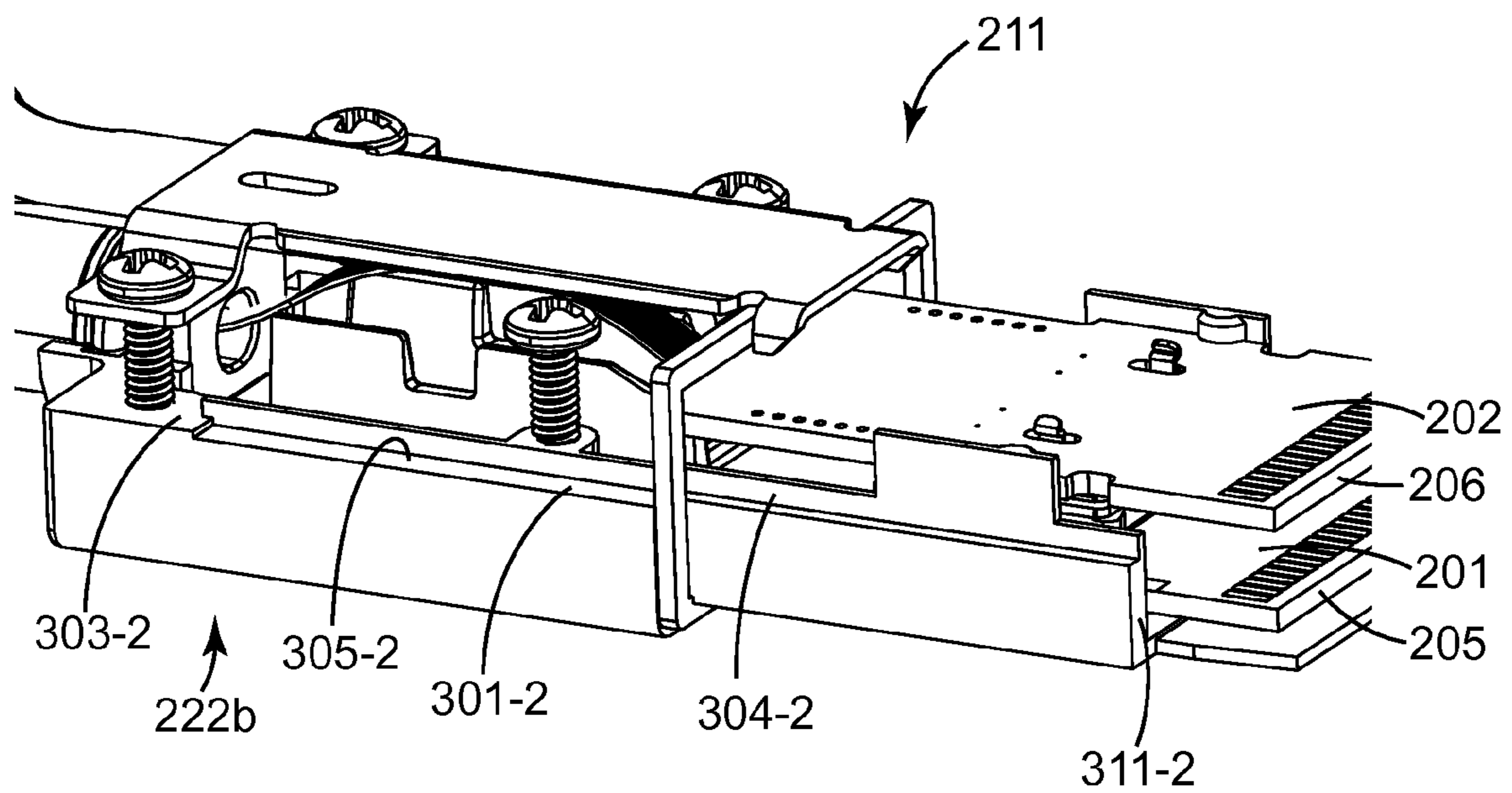


FIG. 3B

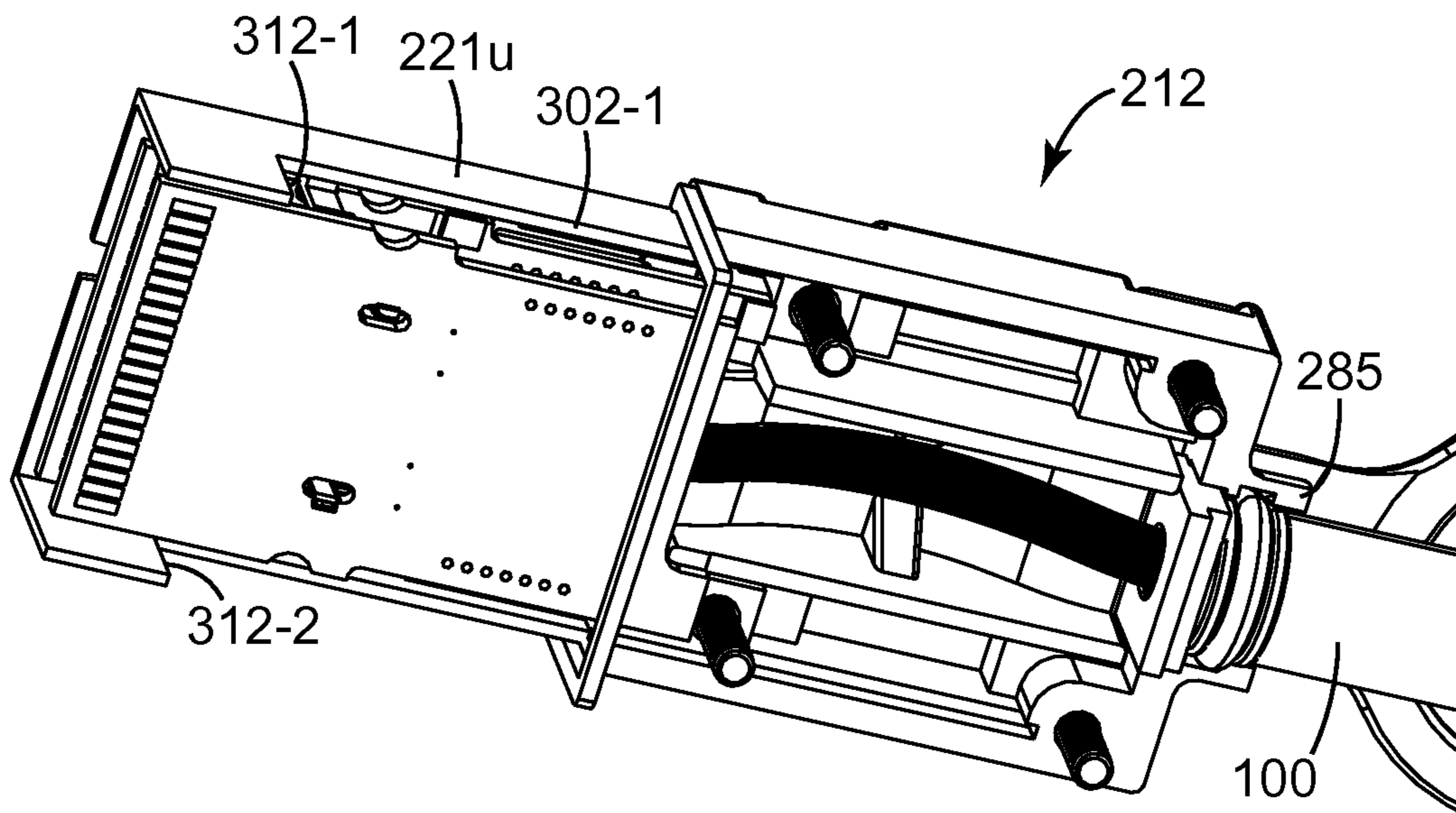


FIG. 3C

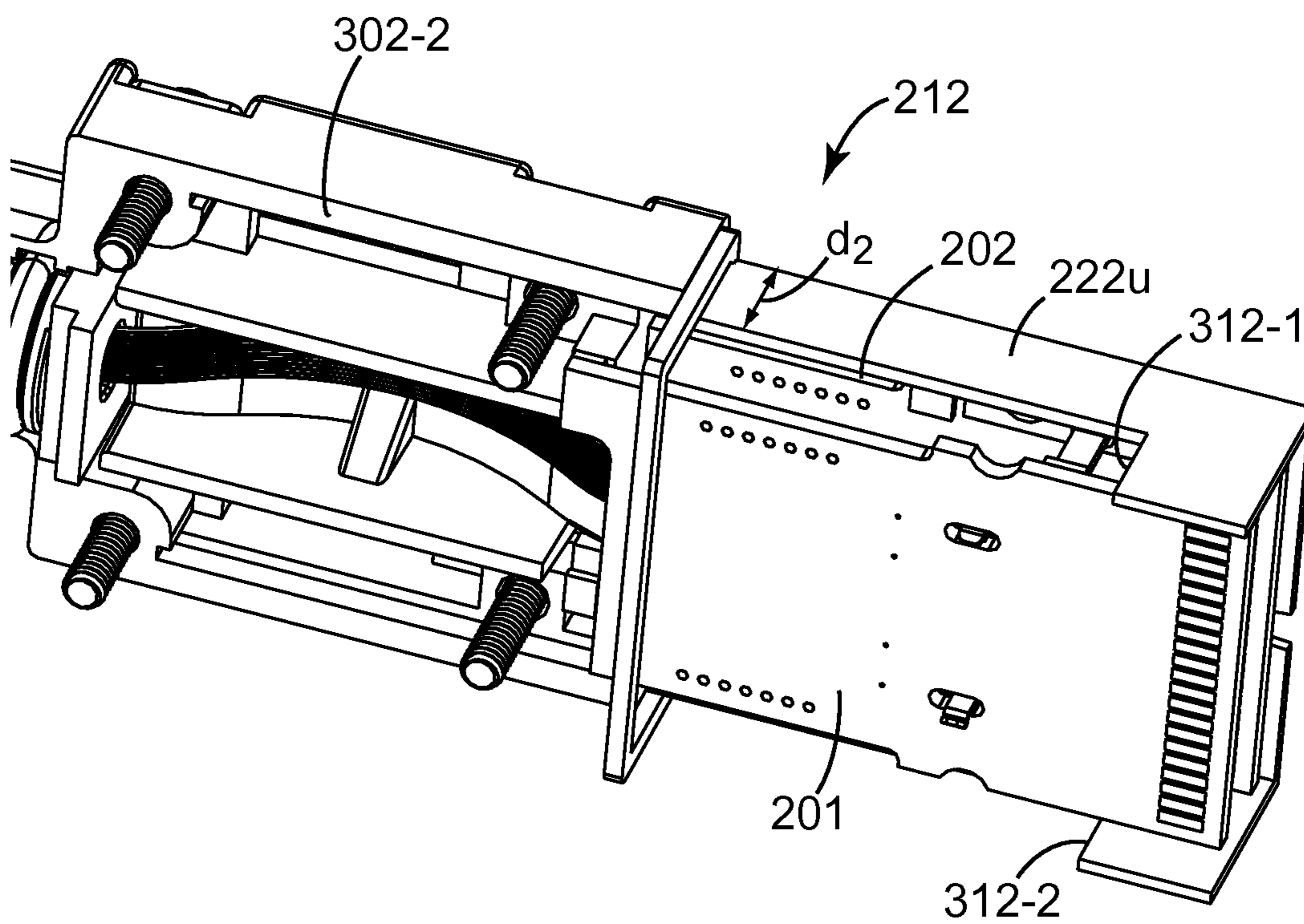
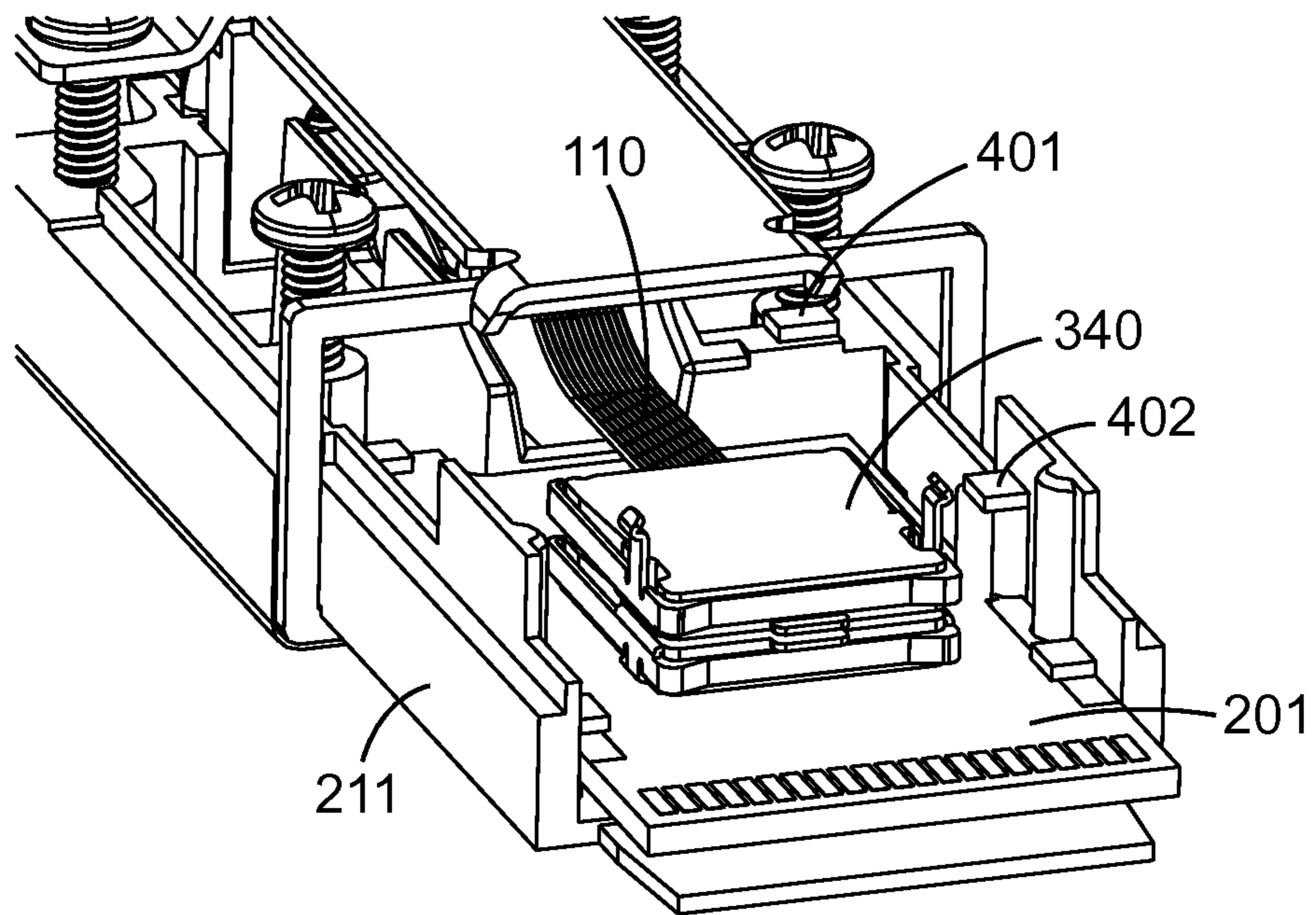
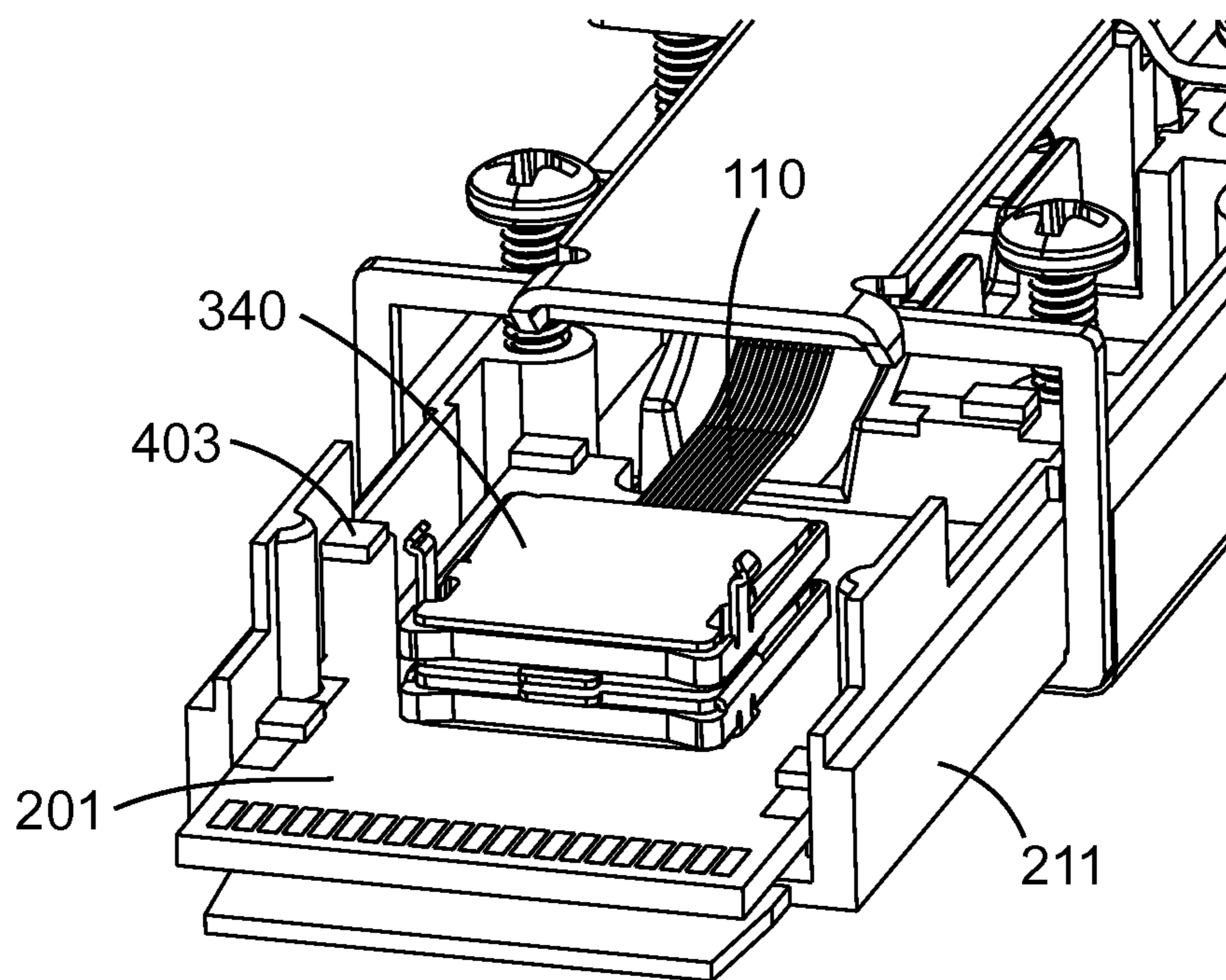


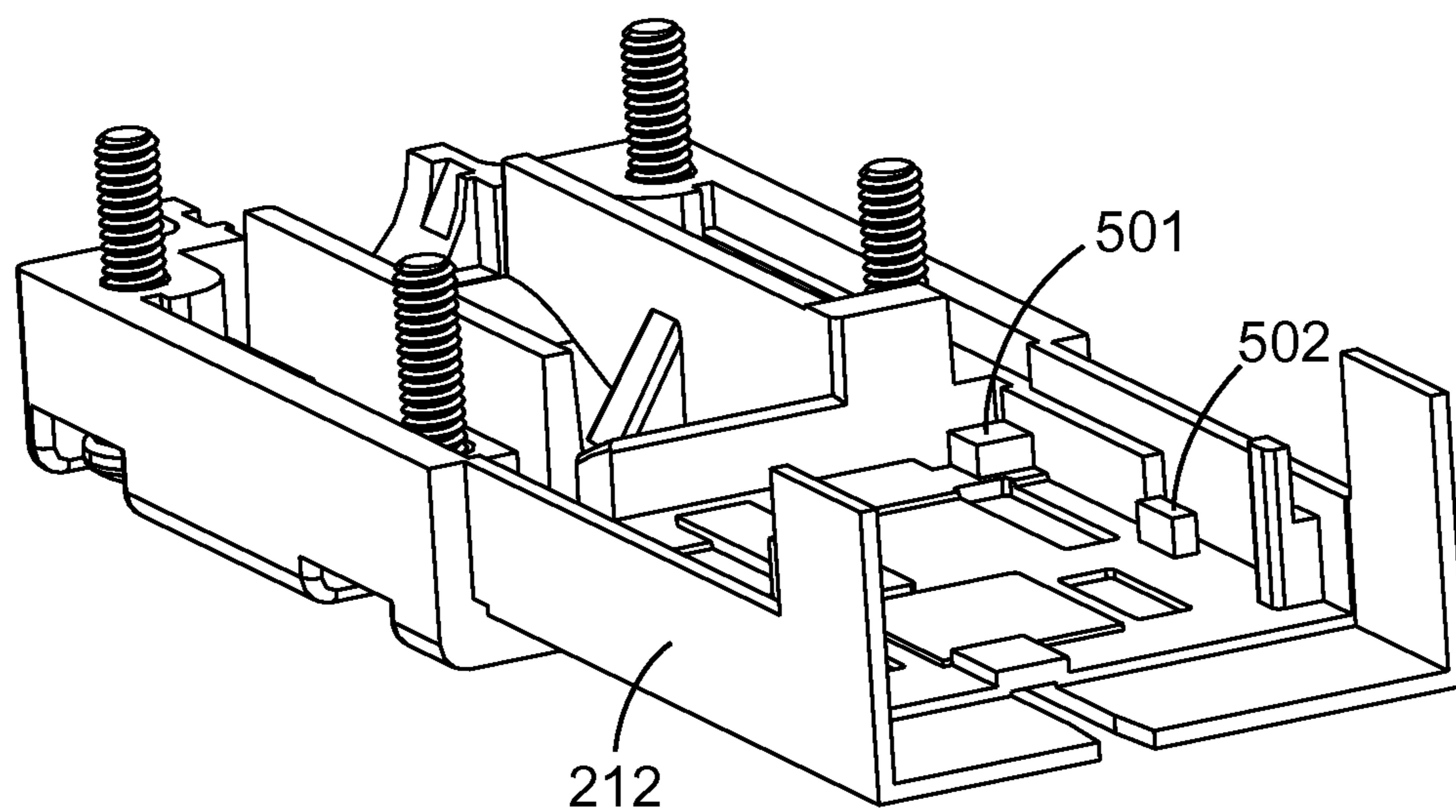
FIG. 3D



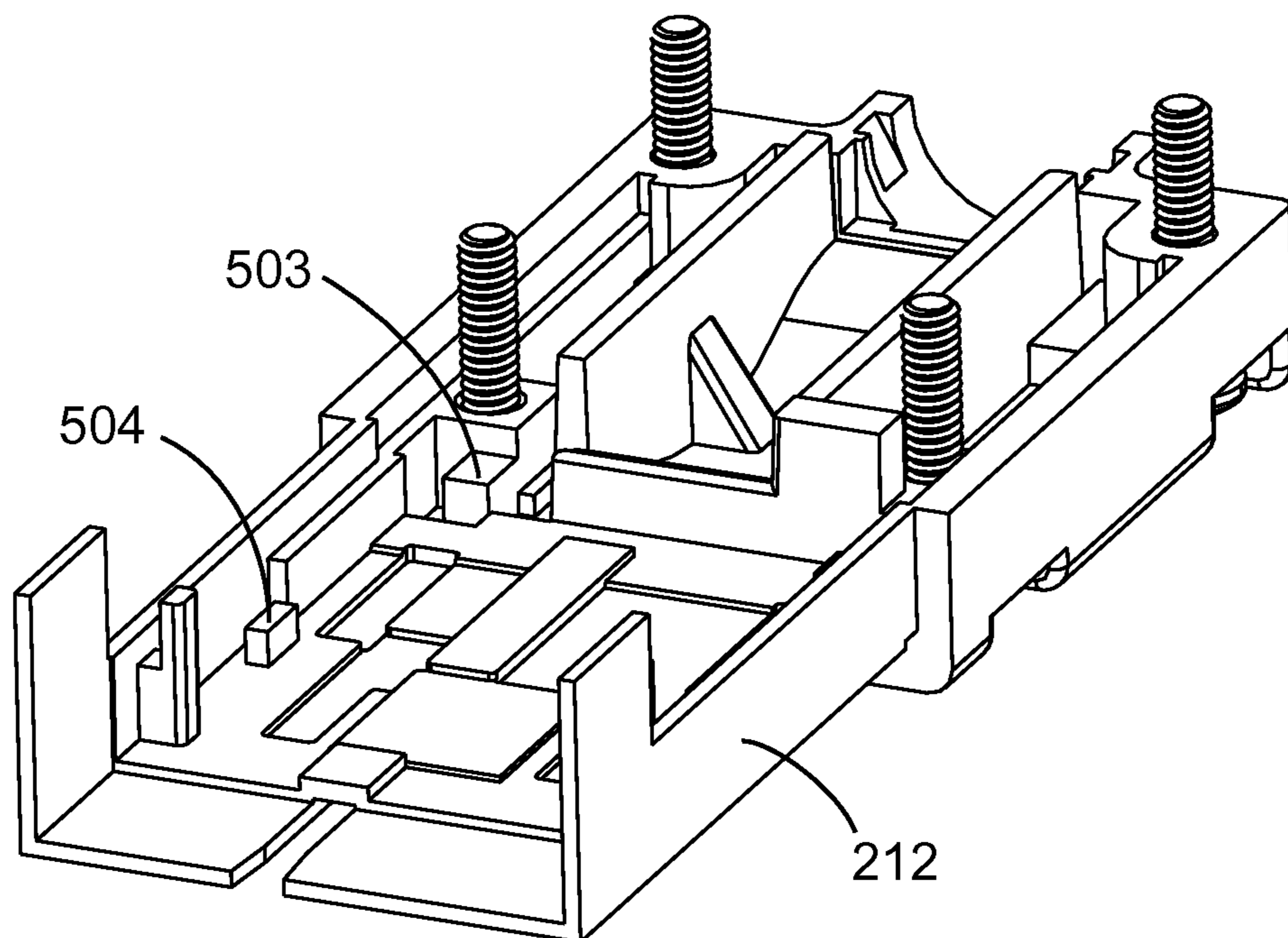
**FIG. 4A**



**FIG. 4B**



**FIG. 5A**



**FIG. 5B**



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**OPTICAL FIBER CONNECTOR ASSEMBLY  
WITH PRINTED CIRCUIT BOARD  
STABILIZATION FEATURES**

BACKGROUND

As compared with traditional wire-based networks, optical-fiber communication networks are capable of transmitting significantly more information at significantly higher speeds. Optical fibers, therefore, are being increasingly employed for communication networks.

SUMMARY

According to some embodiments a plug connector for connecting a cable to a receptacle connector includes a housing comprising an upper housing portion assembled to a lower housing portion. The assembled portions define a cavity within the housing. A plurality of printed circuit boards are disposed in the housing cavity along with a cable which is connected to the plurality of printed circuit boards. The assembled upper and lower housing portions define a first housing sidewall comprising an upper sidewall portion from the upper housing portion and a lower sidewall portion from the lower housing portion. The upper and lower sidewall portions define a gap in the first housing sidewall at an interface between the upper and lower sidewall portions of the first housing sidewall. The gap extends at least partially along a length of the first housing sidewall. In some cases, the gap extends only partially along the length of the first housing sidewall.

The assembled upper and lower housing portions define a second housing sidewall opposite the first housing sidewall, the second housing sidewall comprising an upper sidewall portion from the upper housing portion and a lower sidewall portion from the lower housing portion. The upper and lower sidewall portions define a gap in the second housing sidewall at an interface between the upper and lower sidewall portions of the second housing sidewall. The gap extends at least partially along a length of the second housing sidewall. In some cases, the gap in the second housing sidewall extends only partially along the length of the second housing sidewall.

The gap in the first housing sidewall is defined at an interface between a first lower edge of the upper sidewall portion and a first upper edge of the lower sidewall portion by the first lower edge not being complementary to the first upper edge. In some implementations, the first upper edge has a step at a first location along the first upper edge and the first lower edge does not have a complementary step at the same location along the first lower edge.

According to some implementations, a major surface of a first printed circuit board in the plurality of printed circuit boards is parallel to a major surface of a second printed circuit board in the plurality of printed circuit boards.

According to some aspects, the cable enters the housing cavity through a housing opening and is adapted to transfer a signal to and from the plurality of printed circuit boards. The cable can comprise a plurality of optical fibers.

In some cases, at least one printed circuit board in the plurality of printed circuit boards is held in place in the housing cavity by one or more elastically deformable pads. For example, at least one printed circuit board in the plurality of printed circuit boards is held in place in the housing cavity by a first plurality of deformable pads disposed on a top side of the at least one printed circuit board and a second plurality of deformable pads disposed on a bottom side of the at least

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one printed circuit board. The at least one printed circuit board in the plurality of printed circuit boards can include an optoelectronic component.

The above summary is not intended to describe each disclosed embodiment or every implementation.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. 1A and 1B provide top and cross section views, respectively, of an optical fiber cable;

FIGS. 2A and 2B illustrate two views of an optical fiber plug connector in accordance with embodiments discussed herein;

FIG. 3A is a view of the lower housing including the lower sidewall portion of the first sidewall in accordance with some embodiments;

FIG. 3B shows a view of the lower housing including the lower sidewall portion of the second sidewall in accordance with some embodiments;

FIG. 3C is a view of the upper housing showing the upper sidewall portion of the first sidewall in accordance with some embodiments;

FIG. 3D is a view of the upper housing that shows the upper sidewall portion of the second sidewall in accordance with some embodiments;

FIGS. 4A and 4B show elastically deformable pads disposed in the lower housing portion in accordance with embodiments discussed herein; and

FIGS. 5A and 5B illustrate elastically deformable pads **501-504** disposed in the upper housing portion in accordance with embodiments discussed herein.

While the embodiments are amenable to various modifications and alternative forms, some details are shown by way of example in the drawings in which like reference numbers designate similar elements.

DETAILED DESCRIPTION

Optical fiber cables are designed to carry large amounts of information at high speeds. Each optical fiber cable may include one or more optical fibers that act as waveguides for the optical signal. Information transmitted via the optical fiber cables involves conversion of, electrical signals to optical signals at the transmit end, and then conversion of the optical signals to electrical signals at the receive end. The electrical-to-optical and/or optical-to-electrical conversions are handled by optoelectronic components that are configured to perform the conversions. In some configurations, the optoelectronic components are mounted on printed circuit boards housed within an optical fiber connector.

FIGS. 1A and 1B provide top and cross section views, respectively, of an optical fiber cable **100**. In this example, the optical fiber cable **100** includes eight individual optical fibers **110**, although more or fewer than eight optical fibers may be included in an optical fiber cable. Each optical fiber **110** includes a core **111** surrounded by a cladding **112**. The optical fibers **110** are disposed within an outer jacket **120**, and in some cases, the fibers **110** are moveable along the longitudinal axis within the jacket **120**.

FIGS. 2A and 2B illustrate two views of an optical fiber plug connector **200**. The connector **200** comprises a connector housing **209** which encloses a connector cavity **280**. From the perspective of viewing the mating end **208** of the connector **200**, FIG. 2A provides a view of the right side of the connector **200** and FIG. 2B provides a view of the left side of the connector **200**. As best seen in FIG. 3C, the optical fiber cable **100** is inserted into the connector housing **209** and into

the connector cavity **280** through a housing opening **285**. As best seen in FIGS. 4A and 4B, the optical fibers **110** within the cable **100** may be coupled to one or more optoelectronic components **340** on one or more printed circuit boards (PCBs) disposed within the cavity **280**. During operation, the optical fiber **100** may carry optical signals to and from one or both of the PCBs **201**, **202**. The mating edges **205**, **206** of the two PCBs **201**, **202** are shown at the mating end **208** of the connector **200**. Each of the PCBs **201**, **202** includes electrically conductive edge connector terminals **203**, **204** arranged proximate the mating edge **205**, **206** of the PCB **201**, **202**. The edge connector terminals **203**, **204** are configured to mate with a socket in a complementary receptacle connector (not shown in FIG. 2). When multiple PCBs are present within the cavity **280** of the optical connector housing **209**, all the PCBs may be the same, or one or more first PCBs may be different from one or more second PCBs. In some implementations, as illustrated in FIGS. 2A and 2B, the major surface of the first PCB **201** is substantially parallel to the major surface of the second PCB **202**. In other implementations, the PCBs may have other orientations.

The connector housing **209** includes a lower housing portion **211** and an upper housing portion **212**. The upper and lower housing portions **212**, **211** can be assembled together to form the connector housing **209**. In this example, the lower and upper housing portions **211**, **212** are held together by screws **213**, although other fastening approaches are possible. The connector housing **209** comprises a first sidewall **221** which is shown in FIG. 2A, and a second sidewall **222**, which is shown in FIG. 2B. In this discussion, the first sidewall **221** is designated as the sidewall to the right when the connector **200** is viewed from the mating end **208** and the second sidewall is designated as the sidewall to the left when the connector **200** is viewed from the mating end **208**. It will be appreciated that the terms “upper”, “lower”, “right”, and “left” are all relative terms used for descriptive purposes. The connector may be oriented in any way, e.g. such as an orientation that makes the upper housing portion lower than the lower housing portion, etc.

The first sidewall **221** includes the first sidewall portion **221b** of the lower housing portion **211** and the first sidewall portion **221u** of the upper housing portion **212**. The second sidewall **222** comprises the second sidewall portion **222b** of the lower housing portion **211** and the second sidewall portion **222u** of the upper housing portion **212**. In some embodiments, a first gap **220-1** extends only partially or at least partially along the first sidewall **221**. In some embodiments, a second gap **220-2** extends only partially or at least partially along the second sidewall **222**. In some embodiments both sidewalls, **221**, **222** have gaps **220-1**, **220-2**. The first gap **220-1** in the first sidewall **221** is defined at the interface between the first lower edge of the first upper sidewall portion **221u** and the first upper edge of the first lower sidewall portion **221b**. The first gap **220-1** defines the distance between the first lower edge (see, element **302-1** in FIG. 3C) of the first upper sidewall portion **221u** and the first upper edge (see element **301-1** of FIG. 3A) of the first lower sidewall portion **221b**. The first gap **220-1** is formed because first lower edge of the first upper sidewall portion **221u** is not complementary to the first upper edge of the first lower sidewall portion **221b**.

The second gap **220-2** in the second sidewall **222** is defined at the interface between the first lower edge of the second upper sidewall portion **222u** and the first upper edge of the second lower sidewall portion **222b**. The second gap **220-2** defines the distance between the second lower edge (see, element **302-2** in FIG. 3D) of the second upper sidewall

portion **222u** and the second upper edge (see element **301-2** of FIG. 3B) of the second lower sidewall portion **222b**. The second gap **220-2** is formed because first lower edge of the second upper sidewall portion **222u** is not complementary to the first upper edge of the second lower sidewall portion **222b**. The gap reduces the effects of tolerance stackups within the connector housing. The first and/or second gaps **220-1**, **220-2** may be uniform or non-uniform. In some cases, the first and/or second gaps are about 200  $\mu\text{m}$  or in a range of about 20 to 400  $\mu\text{m}$ .

In some configurations, one or both gaps **220-1**, **220-2** may be uniform along the length of the connector housing **209**. A uniform gap means that the distance defined by the gap between the upper housing portion and the lower housing portion is substantially uniform along the length of the gap. However, in some configurations, at least one gap **220-1**, **220-2** may be non-uniform, meaning that at least at a first point along the gap, the distance between the upper and lower housing portions is different from the distance between the upper and lower housing portions at a second point along the gap **220-1**, **220-2**.

For example, in some implementations, the downward force created by screws **213** may cause the one or both gaps **220-1**, **220-2** to be non-uniform. In this scenario, the distance between the top and bottom housing portions **212**, **211** is smaller in the region where the screws **213** secure the two housing portions **212**, **211** together than in the region nearer to the mating end **208** of the connector **200**. For example, during assembly of the connector, a fixture may be used so that the overall height of the housing will be set for each assembly. Such a process may involve a zero gap closure at the rear set of screws and then a “tuning” of the front set of screws to set the overall height of the housing. The screws may be thread locked in place to lock in the final height with a variable gap distance.

In some embodiments, the force created by the screws **213** may distort one or both housing portions **211**, **212** to create a non-uniform gap. In some implementations, one or both of the housing portions **211**, **212** are intentionally designed to distort when force is applied to create a non-uniform gap.

In some implementations, the upper and lower connector housing portions **212**, **211** may be fabricated so that even without the application of external force, at least one gap is non-uniform. For example, in some implementations, even without an applied external force, e.g. by the screws, the distance between the upper and lower housing portions **212**, **211** is greater nearer the mating end **208** of the connector **200** than the distance between the upper and lower housing portions **212**, **211** at the end of the connector **200** that receives the optical fiber cable **100**. Alternatively, the connector housing **209** may be fabricated so that the gap distance between the upper and lower housing portions **212**, **211** is smaller nearer the mating end **208** of the connector **200** when compared with the gap distance between the upper and lower housing portions **212**, **211** at the end of the connector **200** that receives the optical fiber cable **100**. In some configurations, the difference between the maximum and minimum gap distance for a sidewall may be about 400  $\mu\text{m}$  or the minimum gap distance may be about 5% of the maximum gap.

FIGS. 3A and 3B are views of the lower housing portion **211**, with FIG. 3A is a view of the lower housing **211** including the lower sidewall portion **221b** of the first sidewall **221** and FIG. 3B showing a view of the lower housing **211** including the lower sidewall portion **222b** of the second sidewall **222**. FIG. 3C is a view of the upper housing **212** showing the upper sidewall portion **221u** of the first sidewall and FIG. 3D

is a view of the upper housing **212** that shows the upper sidewall portion **222u** of the second sidewall **222**.

In the particular configurations illustrated in FIGS. **3A** through **3D**, the housing **209** is configured to contain two PCBs **201**, **202** within the housing cavity **280**. Each of FIGS. **3A** through **3D** show both PCBs **201**, **202**.

The first upper edge **301-1** of the first lower sidewall portion **221b**, is shown in FIG. **3A**. The second upper edge **301-2** of the second lower sidewall portion **222b** is shown in FIG. **3B**. The first lower edge **302-1** of the first upper sidewall portion **221u** of the second sidewall **222** is shown in FIG. **3C**. The second lower edge **302-2** of the second upper sidewall portion **222u** of the second sidewall **222** is shown in FIG. **3D**. The first upper edge **301-1** has a step **303-1** at a first location along the first upper edge **301-1**, however, the first lower edge **302-1** does not have a step at a corresponding location on the first lower edge **302-1**. Similarly, the second upper edge **301-2** has a step **303-2** at a first location along the second upper edge **301-2**, however, the second lower edge **302-2** does not have a step at a corresponding location on the second lower edge **302-2**. The height of the steps **303-1**, **303-2** may at least partially define the size of the gap. For example, the height of the step may be about 200  $\mu\text{m}$ . At least one of the upper and lower sidewall portions may include a lip. For example, as depicted in FIGS. **3A** and **3B** the first and second upper edges include lips **304-1**, **304-2**. When assembled, the first lower edge **302-1** sits on the first shelf **305-1** outside lip **304-1** and the second lower edge **302-2** sits on the second shelf **305-2** outside lip **304-2**.

As shown in FIGS. **3A** through **3D**, the first and second upper sidewall portions **221u**, **222u**, can have an L-shape, with the short portion of the L-shape being disposed at the mating edge **208** of the connector **200**. In some cases, the thickness of the first **221b** and second **222b** lower sidewall portions,  $d_1$ , is greater than the thickness of the long portion of the L shape,  $d_2$ . However, in some cases,  $d_1$  is less than or equal to  $d_2$ . Each of the first and second lower sidewall portions **221b**, **222b** have a truncated edge **311-1**, **311-2**, meaning that the first and second lower sidewall portions **221b**, **222b** do not extend all the way to the mating edges **205**, **206** of the circuit boards **201**, **202** at the mating end **208** of the connector. When the connector housing **209** is assembled, edges **312-1**, **312-2** of the short portions of the L-shaped upper and lower sidewall portions **221u**, **222u** fit together with the truncated edges **311-1**, **311-2** of the lower sidewall portions **221b**, **222b**.

The connector housing **209** can include one or more elastically deformable pads that are configured to support and hold at least one PCB **201**, **202** in place within the housing cavity. Suitable materials for the elastically deformable pads include silicone suitable for optoelectronic PCB applications. Suitable materials for the elastically deformable pads include elastomers such as silicone rubber, nitrile rubber, latex rubber, polyacrylic rubber, polyurethane, polybutadiene, and fluoroelastomers. Material characteristics of the pads include adequate compliance and modulus to provide sufficient retention force on the PCB, as well as negligibly small flow and good thermal and chemical stability so that the retention force will be maintained over the use life of the system. A high coefficient of sliding friction, potentially enhanced by texturing the surface of the elastomeric pad, may be employed to enhance gripping the PCB,

The deformable pads may be disposed in the upper housing portion and/or in the lower housing portion. Deformable pads **401**, **402**, **403** disposed in the lower housing portion **211** are illustrated in FIGS. **4A** and **4B**. Deformable pads **501-504** disposed in the upper housing portion **212** are shown in FIGS.

**5A** and **5B**. Pads **401**, **402**, **403** make contact with at least one PCB **202** (see, FIG. **3D**) on a bottom side of the PCB **202** to provide support for the at least one PCB **202** and/or to hold the at least one PCB **202** in place. Pads **501**, **502**, **503**, **504** make contact with a top side of the PCB **202** to provide support for and/or to hold the at least PCB **202** in place. Although three pads **401**, **402**, **403** are shown in the lower housing portion **211** and four pads are shown in the upper housing portion, in various configurations, more or fewer pads may be used.

The elastically deformable pads **401-403**, **501-504** may operate cooperatively with the gap to hold one or more PCBs in place with the optimal amount of structural support while allowing sufficient tolerances in the connector housing. From connector housing to connector housing, the elastically deformable pads may be compressed and deformed by a variable amount with the variation in deformation of the elastically deformable pads causing differences in the gap size from connector housing to connector housing. The variation in gap size and/or amount of deformation of the elastically deformable pads allows the PCBs to be securely held in place with appropriate tolerances between adjacent structures.

Item 1 is a plug connector for connecting a cable to a receptacle connector, comprising:

a housing comprising an upper housing portion assembled to a lower housing portion, the assembled portions defining a cavity within the housing;

a plurality of printed circuit boards disposed in the housing cavity;

a cable disposed in the housing cavity and connected to the plurality of printed circuit boards;

wherein the assembled upper and lower housing portions define a first housing sidewall comprising an upper sidewall portion from the upper housing portion and a lower sidewall portion from the lower housing portion, the upper and lower sidewall portions defining a gap in the first housing sidewall at an interface between the upper and lower sidewall portions of the first housing sidewall, the gap extending at least partially along a length of the first housing sidewall.

Item 2 is the plug connector of item 1, wherein gap extends only partially along the length of the first housing sidewall.

Item 3 is the plug connector of item 1, wherein the assembled upper and lower housing portions define a second housing sidewall opposite the first housing sidewall, the second housing sidewall comprising an upper sidewall portion from the upper housing portion and a lower sidewall portion from the lower housing portion, the upper and lower sidewall portions defining a gap in the second housing sidewall at an interface between the upper and lower sidewall portions of the second housing sidewall, the gap extending at least partially along a length of the second housing sidewall.

Item 4 is the plug connector of item 3, wherein gap in the second housing sidewall extends only partially along the length of the second housing sidewall.

Item 5 is the plug connector of item 1, wherein the gap in the first housing sidewall is defined at an interface between a first lower edge of the upper sidewall portion and a first upper edge of the lower sidewall portion by the first lower edge not being complementary to the first upper edge.

Item 6 is the plug connector of item 5, wherein the first upper edge has a step at a first location along the first upper edge and the first lower edge does not have a complementary step at the same location along the first lower edge.

Item 7 is the plug connector of item 1, wherein a major surface of a first printed circuit board in the plurality of printed circuit boards is parallel to a major surface of a second printed circuit board in the plurality of printed circuit boards.

Item 8 is the plug connector of item 1, wherein the cable is adapted to transfer a signal to and from the plurality of printed circuit boards.

Item 9 is the plug connector of item 1, wherein the cable enters the housing cavity through a housing opening.

Item 10 is the plug connector of item 1, wherein at least one printed circuit board in the plurality of printed circuit boards is held in place in the housing cavity by one or more elastically deformable pads.

Item 11 is the plug connector of item 1, wherein at least one printed circuit board in the plurality of printed circuit boards is held in place in the housing cavity by a first plurality of elastically deformable pads disposed on a top side of the at least one printed circuit board and a second plurality of elastically deformable pads disposed on a bottom side of the at least one printed circuit board.

Item 12 is the plug connector of item 1, wherein the cable comprises a plurality of optical fibers.

Item 13 is the plug connector of item 1, wherein at least one printed circuit board in the plurality of printed circuit boards comprises an optoelectronic component.

Item 14 is an optical fiber connector, comprising:

a housing comprising an upper housing portion assembled to a lower housing portion, the assembled portions defining a cavity within the housing;

one or more printed circuit boards disposed in the housing cavity; and

one or more elastically deformable pads configured to hold at least one of the one or more printed circuit boards in place within the housing cavity.

Item 15 is the connector of item 14, wherein the one or more elastically deformable pads comprises:

a first plurality of elastically deformable pads disposed on a top side of the at least one printed circuit board; and

a second plurality of elastically deformable pads disposed on a bottom side of the at least one printed circuit board.

Item 16 is the connector of item 15, wherein:

the first plurality of elastically deformable pads disposed between the top side of the at least one printed circuit board and a top wall of the upper housing portion; and

a second plurality of elastically deformable pads disposed between the bottom side of the at least one printed circuit board and a lower wall of the lower housing portion.

The embodiments discussed in this disclosure have been illustrated and described herein for purposes of description of preferred embodiments, it will be appreciated by those of ordinary skill in the art that a wide variety of alternate and/or equivalent implementations calculated to achieve the same purposes may be substituted for the specific embodiments shown and described without departing from the scope of the present invention. Those with skill in the mechanical, electro-mechanical, and/or electrical arts will readily appreciate that the disclosed embodiments may be implemented with vary wide variations. This application is intended to cover any adaptations or variations of the preferred embodiments discussed herein.

The invention claimed is:

**1.** A plug connector for connecting a cable to a receptacle connector, comprising:

a housing comprising an upper housing portion assembled to a lower housing portion, the assembled portions defining a cavity within the housing;

a plurality of printed circuit boards disposed in the housing cavity;

a cable disposed in the housing cavity and connected to the plurality of printed circuit boards;

wherein the assembled upper and lower housing portions define a first housing sidewall comprising an upper sidewall portion from the upper housing portion and a lower sidewall portion from the lower housing portion, the upper and lower sidewall portions defining a gap in the first housing sidewall at an interface between the upper and lower sidewall portions of the first housing sidewall, the gap extending at least partially along a length of the first housing sidewall,

wherein the plug connector further comprises one or more elastically deformable pads configured to hold at least one of the plurality of printed circuit boards in place within the housing cavity,

wherein the one or more elastically deformable pads comprise:

a first plurality of elastically deformable pads disposed between a top side of the plurality of printed circuit boards and a top wall of the upper housing portion; and

a second plurality of elastically deformable pads disposed between a bottom side of the plurality of printed circuit boards and a lower wall of the lower housing portion.

**2.** The plug connector of claim 1, wherein gap extends only partially along the length of the first housing sidewall.

**3.** The plug connector of claim 1, wherein the assembled upper and lower housing portions define a second housing sidewall opposite the first housing sidewall, the second housing sidewall comprising an upper sidewall portion from the upper housing portion and a lower sidewall portion from the lower housing portion, the upper and lower sidewall portions defining a gap in the second housing sidewall at an interface between the upper and lower sidewall portions of the second housing sidewall, the gap extending at least partially along a length of the second housing sidewall.

**4.** The plug connector of claim 3, wherein the gap in the second housing sidewall extends only partially along the length of the second housing sidewall.

**5.** The plug connector of claim 1, wherein the gap in the first housing sidewall is defined at an interface between a first lower edge of the upper sidewall portion and a first upper edge of the lower sidewall portion by the first lower edge not being complementary to the first upper edge.

**6.** The plug connector of claim 5, wherein the first upper edge has a step at a first location along the first upper edge and the first lower edge does not have a complementary step at the same location along the first lower edge.

**7.** The plug connector of claim 1, wherein a major surface of a first printed circuit board in the plurality of printed circuit boards is parallel to a major surface of a second printed circuit board in the plurality of printed circuit boards.

**8.** The plug connector of claim 1, wherein the cable is adapted to transfer a signal to and from the plurality of printed circuit boards.

**9.** The plug connector of claim 1, wherein the cable enters the housing cavity through a housing opening.

**10.** The plug connector of claim 1, wherein at least one printed circuit board in the plurality of printed circuit boards is held in place in the housing cavity by one or more elastically deformable pads.

**11.** The plug connector of claim 1, wherein the cable comprises a plurality of optical fibers.

**12.** The plug connector of claim 1, wherein at least one printed circuit board in the plurality of printed circuit boards comprises an optoelectronic component.

13. An optical fiber connector, comprising:  
a housing comprising an upper housing portion assembled  
to a lower housing portion, the assembled portions  
defining a cavity within the housing;  
a plurality of printed circuit boards disposed in the housing 5  
cavity; and  
one or more elastically deformable pads configured to hold  
at least one of the plurality of printed circuit boards in  
place within the housing cavity, the one or more elasti-  
cally deformable pads comprising a first plurality of 10  
elastically deformable pads disposed between a top wall  
of the upper housing portion and a top side of the plu-  
rality of printed circuit boards, and a second plurality of  
elastically deformable pads disposed between a lower  
wall of the lower housing portion and a bottom side of 15  
the plurality of printed circuit boards.

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